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Integration of pharmacogenetic principles as a core thread in the undergraduate pharmacy curriculum

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Abstract

Introduction: Pharmacy education needs to focus on pharmacogenetics/pharmacogenomics as a key area in future pharmacy practice.

Module Description: A series of science-focused lectures, including one on the ethical, legal and social implications (ELSI) of pharmacogenetics/pharmacogenomics, and laboratory practical sessions were delivered to first year students. Laboratory sessions were conducted to isolate genetic material from class participants, identify three variant genotypes within this population and demonstrated the implications of this genetic diversity for prescribing.

Assessment Method: Students submitted a report, structured as an academic paper, documenting the study results and the implications of pharmacogenetics/pharmacogenomics for patient care.

Evaluation: Focus groups comprising students evaluated the module as useful for furthering their understanding of pharmacogenetics/pharmacogenomics in practice. Of particular value was (1) receiving the module in year 1 as a fundamental part of the MPharm programme, (2) utilising laboratory methods and using students' own genetic material and (3) integrating ELSI into the module.

Future Plans: Pharmacogenetic implications will be built upon throughout the integrated curricula of the pharmacy course to further develop the student awareness of personalized medicines. Extended awareness of the clinical implications of pharmacogenetics/pharmacogenomics and associated ELSI has been built into a second year interprofessional education (IPE) workshop facilitated by clinical geneticists and involving both pharmacy and medical students.

Keywords: *ELSI, Hypertension, Pharmacogenetics, Pharmacogenomics, Pharmacy Education*

Introduction

Pharmacogenetics/pharmacogenomics, that is the response to medicines based upon hereditary factors, has led to the prescription of medicines based on a patients' genetic information, referred to as personalised medicine (Li-Wan-Po, 2012). This has been identified as a key element of future pharmacy practice in the United Kingdom (UK) and elsewhere (El-Ibiary *et al*., 2008). Research has identified that in order to fully prepare pharmacists for this type of practice, undergraduate pharmacy education, and indeed on-going professional development, needs to focus on the principles and practices of this developing science (Jamie, 2013). In order to introduce students to the field, a series of lectures, workshops and practical-based laboratory classes focused on the principles and clinical implications of pharmacogenetics/pharmacogenomics were delivered as an integrated theme within our integrated Masters of Pharmacy (MPharm) undergraduate course (Husband *et al*., 2014).

Description of the Course and Assessments

The course was delivered through a series of science-focused lectures (3 hours) and practical-based laboratory practical sessions (3 x 4 hours) by a molecular pharmacologist (JG). The final lecture of the term (2 hours) was delivered by a social scientist with a specialist interest in genetics (KJ) and focused on the ethical, legal social and professional implications of pharmacogenetics/ pharmacogenomics. Figure 1 shows the development and delivery of the teaching.

Students on the course were in the initial training year of their pharmacy education and had previously received lectures on the fundamental principles of biological, chemical and pharmaceutical sciences. They then received the lecture series focused on genetics and its application to clinical pharmacy. This was aimed at establishing a basic appreciation of the knowledge of the practical skills and fundamental principles of the field. The laboratory classes were delivered as three distinct but interrelated sessions and were structured around the

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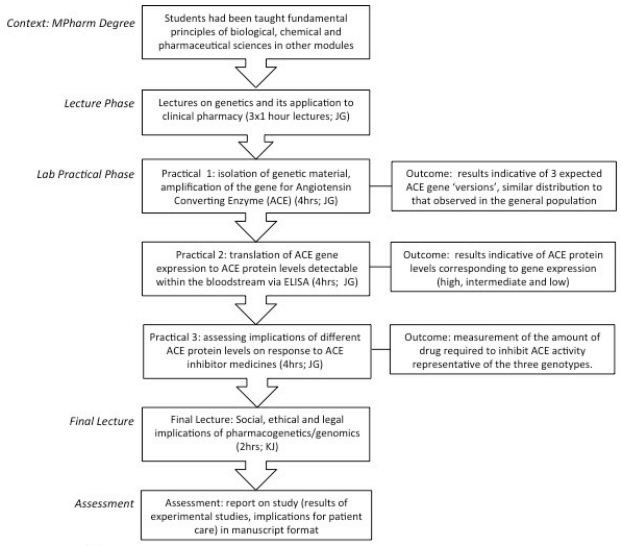
application of specific laboratory techniques, with progressive outcomes relating to the clinical implications of pharmacogenetics/pharmacogenomics.

Figure 1: Teaching and Assessment Flow



The initial session involved isolation of genetic material obtained from anonymised cheek swabs of class participants and support staff (after receiving their informed consent), followed by amplification of the gene for Angiotensin Converting Enzyme (ACE), using a modification of the methodology previously described by Knoell and colleagues (Knoell *et al*., 2009). The ACE gene was chosen based on its known polymorphic nature, its centrally important role in the pathophysiologic regulation of hypertension, and its clinical importance as a therapeutic target for disease management (Rigat *et al*., 1990). This initial phase provided results indicative of the three expected ACE gene 'versions' (termed genotypic variants), with similar distribution profiles to that observed in the general population (Rigat *et al*., 1990).

The second phase of the laboratory study focused on translation of ACE gene expression to ACE protein levels detectable within the bloodstream, via a standard clinically-applicable quantitative assay; an Enzyme-linked immunosorbent assay (ELISA). Although this ELISA was cost-effectively developed to detect a different protein this was not communicated to students and the results obtained were indicative of the ACE protein levels corresponding to gene expression (high, intermediate and low ACE protein levels).

The third and final laboratory class contextualized the study by assessing the implications of the different ACE protein levels on response to the clinically applicable ACE inhibitor medicines, via measurement of the amount of drug required to inhibit ACE activity representative of the three genotypes.

The students then submitted a report documenting the study, including the results of the three phases of the experimental studies, and discussing their observations in light of the clinical scenario and implications of pharmacogenetics/pharmacogenomics on patient care. This report was structured into a format representative of a manuscript for submission to a scientific journal, relating a concept to clinic approach. This submission was then assessed against defined criteria, with the resulting mark forming a component of their grade for the first year of their undergraduate course.

Evaluation

Evaluation was carried out through qualitative focus groups.

The use of focus groups allowed us to gather rich data about students' perspectives on the module content and delivery. Focus groups consisted of between 3-7 students with 21 students participating in total (from a total class size of 30 students) and were undertaken by HB, who is a qualitative social scientist and had not taught on the module. Focus group data highlighted three key strengths of the module.

Firstly, the positioning of the module in the first year of the MPharm degree emphasized the importance of pharmacogenetics/pharmacogenomics to pharmacists' work in the future. Teaching pharmacogenetics/pharmacogenomics alongside content such as basic anatomy and chemistry positions the field as fundamental to understanding the pharmacokinetics and pharmacodynamics of medicines.

Secondly, students reported finding laboratory practical sessions more useful than classroom-based teaching. Using students own DNA to predict drug reactions was positively received and reported by students to better illuminate the application of pharmacogenetics/pharmacogenomics than classroom-based teaching. This practical way of teaching pharmacogenetics/pharmacogenomics also speaks to students with diverse learning styles.

Thirdly, the integration of social and ethical dimensions of pharmacogenetics/pharmacogenomics was highlighted by students as a particular positive. Many students reported not having thought extensively about the impact of pharmacogenetics/pharmacogenomic practice on patients before undertaking the module. The integration of social and ethical dimensions stimulated students to think critically and reflectively about their role in addressing social and ethical issues with their patients.

Future Plans

Based on the feedback from these focus groups, we have made a number of plans for integrated delivery of pharmacogenetics/pharmacogenomics and personalized medicine into the MPharm programme, primarily through inclusion of indicative information embedded within lectures focused on therapeutics throughout the following three years of the course.

To contextualise the clinical importance of genetics to patient care and therapeutic disease management, and to further explore the ethical, legal and social implications (ELSI) therein, we have created a second year interprofessional education (IPE) workshop led by senior clinical geneticists. This IPE workshop involves collaborative working between pharmacy and medicine students, and is clinically case-based involving evaluation of genetic histories, disease pathophysiology, adapted therapeutic management, and clinical communication skills.

The pharmacogenetics/pharmacogenomics educational theme spirals throughout the MPharm programme then culminates in year 4 with a focus on the treatment of complex multi-factor diseases, particularly in oncology, for which personalized medicines are becoming standard treatment (Li-Wan-Po, 2012).

Key Resources for Students and Educators

Hedgecoe, A. (2004). The Politics of Personalised Medicine. Cambridge: Cambridge University Press.

Strachen, T., Goodship, J. & Chinnery, P. (2014). Genetics and Genomics in Medicine. New York: Garland Science.

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